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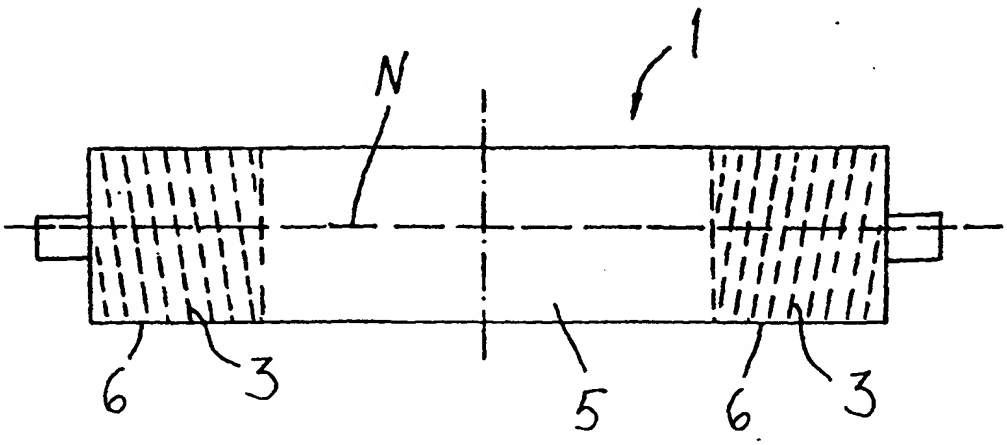

(57) Abstract

A reel-up for a paper web comprises a reeling cylinder (1) equipped with a grooving (3) on the mantle surface, a reel spool (2) around which the web (W) is reeled into a reel (R), as well as means for loading the reel spool (2) and the reeling cylinder (1) against each other to achieve a reeling nip (N) between the reeling cylinder (1) and the reel (R). The grooving comprises parallel flat or shallow grooves (7), which form a grooving whose total cross-sectional area is greater in the edge areas (6) of the mantle of the reeling cylinder (1) than in the central area (5) of the mantle of the reeling cylinder (1). The grooving is used to control the behaviour of air during the reeling.

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Reel-up of a paper web and cylinder thereof

The invention relates to a reel-up in a paper machine or paper after-treatment device to prevent the emergence of an air bag or layer before the nip between the reeling cylinder and the reel underneath the uppermost layers of the reel to be formed of the paper web, as well as wrinkling of the paper web on the reel, caused by a possible bag. The invention also relates to a cylinder in the reel-up of a paper web.

In a paper machine or correspondingly in another device processing web-like product, the finished paper web is reeled up at the end of the machine on a reel-up around a roll that is called a reel spool. The roll that consists of the full-width paper web running around the reel spool from the machine is called a machine reel. The reeling device consists of a reeling cylinder which rotates at a peripheral speed corresponding to the speed of the paper web and which is journalled by means of shafts at its ends on the frame of the reeling device, and at one end of the cylinder the reeling cylinder is coupled to a drive device which, in turn, is coupled to the drive of the whole machine in such a way that the peripheral speed of the reeling cylinder corresponds to the speed of the finished paper web running from the machine. This reel-up type is also called a Pope reel-up. The finished web is collected onto the reel spool in the reeling position at the same time when the spool is loaded towards the reeling cylinder. The reel spool can receive its driving force by means of friction through the paper web from the reeling cylinder (Pope reel-up with a so-called peripheral drive), or it is, according to a presently common solution, provided with a drive, wherein it is called a reel-up with centre drive. When a sufficient quantity of paper web has been accumulated on the reel spool, the reel is removed from the surface of the reeling cylinder. The peripheral speed of the reel is reduced as the reel is decelerated, and before the reel spool, the web forms a bag which is guided by means of an air stream around a new reel spool brought onto the reeling cylinder. The paper web running onto the full reel spool is immediately broken and starts to coil up on the new reel spool. There are also other change techniques in use, and they are dependent *e.g.* on the grammage of the paper.

A reel-up used for the reeling of machine reels is also known, wherein the reel spool rotates in a stationary position and the reeling cylinder is loaded against the reel and is moved according to the growth of the reel.

In the former reel-up types, it is also possible to use auxiliary rolls which are in contact with the reel. Furthermore, there are other reel-up types in which a rotating roll or cylinder is at a given pressure in contact with the roll being formed of paper, such as pressure roller reel-ups and carrier-roll reel-ups.

In the manufacture of certain printing paper grades which are thin or have a slippery surface (such as LWC and SC grades), the paper web may slip on the surface of the reeling cylinder. This may occur when the growing paper reel receives its driving force for rotating directly from the reeling cylinder by means of friction. In this case the friction between the paper web and the reeling cylinder is not sufficient and slipping occurs, which causes that the peripheral speed of the rell is slightly lower than the peripheral speed of the reeling cylinder and the speed of the web to be reeled on the machine reel. Because of the speed difference, the tension of the paper web between the reeling cylinder and the reel spool is reduced, resulting in uncontrolled variations in tension and hardness, which cause looseness and wrinkles in the roll and may also cause broke in the after-treatment of the roll.

Attempts have been made to increase the friction between the paper web and the reeling cylinder in several different ways. First of all, the slipping of the paper web is dependent on the tension of the paper web at which it is pressed over its contact area against the surface of the reeling cylinder. A second factor is the linear pressure at which the machine reel is pressed or it is pressed by gravity against the reeling cylinder. Furthermore, the surface quality of the paper and the rolls affect the friction coefficient between the same. By providing the reel spool with a drive of its own, it is possible to eliminate said problems.

In spite of the centre drive, the reeling operation is, nevertheless, disturbed at the present high and ever increasing speeds by the fact that the high speed of the reeling cylinder and the incoming web induces air into a movement towards the inlet gap between the web and the reeling cylinder, the web entering the surface of the reeling cylinder at the end of the inlet gap. Thus, an overpressure is developed in the gap, causing that air penetrates between the reeling cylinder and the incoming paper web. Particularly in the case of wide, fast machines and paper grades with poor air permeability, an air bag will thus be developed on the side of the reeling cylinder just before the reeling nip between the reeling cylinder and the reel. On the other hand, in spite of the linear pressure of the reeling nip, air penetrates into the nip between the incoming web and the reel, which will be left between the layers and will loosen the structure of the reel and make further processing difficult, particularly in the case of slippery paper grades. Air left between the uppermost paper layers to be reeled on the reel spool and the rest of the reel can accumulate by the effect of the reeling nip into a bag just in front of the reeling nip. If these above-mentioned air bags cannot be controlled, they will cause wrinkles in the reel when falling into the nip, and they limit the maximum speed of the reel-up.

A major factor to reduce friction between the paper web and the reeling cylinder is air being funnelled into the gap between the incoming web and the reeling cylinder. The paper web being very wide (normally at least 5 m) in present machines, air left underneath the paper web cannot escape from between the web and the cylinder. Attempts have been made to eliminate this problem by various methods. As prior art, the publications FI-74446 and FI-98506 can be mentioned. In the former, a perforated suction cylinder having a perforated mantle is used as the reeling cylinder, inside which there is a suction box whose suction zone is arranged in the area in which the web touches the surface of the mantle of the reeling cylinder. To obtain an underpressure in the reeling cylinder, the air must be conducted from inside the cylinder through the cylinder shaft to a suction pump. In the publication FI-98506, the surface of the mantle of the reeling cylinder is provided with grooves, on the bottom of which there is perforation extending through the mantle. An underpressure is developed inside the cylinder by a

suction pump, to which there is a connection from inside the cylinder through one end of the cylinder. The holes induce a pressure loss in the air passing through the mantle, wherein an underpressure is developed inside the cylinder. In both of the constructions presented in the publications, it is essential that both the perforation and the grooves extend over the whole width of the mantle of the reeling cylinder.

In addition, grooved reeling cylinders with no suction are used. Thus, the purpose is to guide the air by means of the grooves only. Relatively deep and narrow (about. 4 mm × 2 mm) grooves, extending in the direction of the periphery in a spiral-like fashion from the centre towards the edges, are used to guide the air, pumped into the gap between the incoming web and the reeling cylinder, between the web and the reeling cylinder and past the reeling nip between the reeling cylinder and the reel. To avoid marking caused by the grooves, the sharp edges of the grooves must be rounded.

Furthermore, a similar grooving has been used, arranged to extend spirally from the centre towards the edges over the whole width of the cylinder and consisting of a shallow and wide (appr. 1 mm × appr. 30 mm) gently sloping "flat" groove. The aim is here to eliminate the drawbacks of overpressure developed in the nip between the incoming web and the reel by letting a suitable quantity of air to enter between the paper layers and by leading out extra air. It is also possible to use a combination of a deep, narrow grooving and a shallow grooving. The drawback of the shallow grooving is that the nip profile becomes complex, because the surface of the reeling cylinder has little area that is completely even. Problems may thus occur with thin paper grades.

Because of the way of loading (loading of the reel spool by power units at the ends towards the reeling cylinder) as well as bending caused by gravity, the entry of air flows is not uniform over the width of the reel and the reeling cylinder. Because the loading is greater at the edges of the reel, air is passed between the web and the reel in the reeling nip more easily in the centre than at the edges, and in spite of the shallow grooving, air cannot flow via the tight edges out of the reel. A reduction of the load will, in turn, result in a decreased linear pressure and too

loosely-wound a roll. In a corresponding manner, the same uneven distribution of loading in the reeling nip will cause that air passed between the reeling cylinder and the web can flow past the nip between the reeling cylinder and the reel better in the centre than at the edges, wherein problems with air bags on the side of the reeling cylinder can be expected more at the edges.

It is the aim of the present invention to maintain the reeling properties of the reel-up but to offer a less expensive and more advantageous solution for the manufacture. To put it more precisely, the construction of a reel-up according to the invention is characterized in what will be presented in the characterizing part of claim 1. The cylinder according to the invention is, in turn, characterized in what will be presented in the characterizing part of the appended claim 13.

According to the invention, the surface of the reeling cylinder is provided with a grooving consisting of parallel shallow grooves whose total cross-sectional area is greater at the edges than in the central area. The shallow grooving can be provided only on part of the mantle at the edge areas of the cylinder in such a way that the central area of the cylinder is smooth, or the central area can be equipped with shallow grooves having a smaller cross-sectional area or spaced more sparsely. A grooving placed on only the edge areas of the mantle of the cylinder reduces work time spent on the manufacture of the cylinder. Compared with cylinders provided with shallow grooves on their whole surface, the cylinder with a smooth central area has a considerably larger uniform loading surface and a smaller risk of marking. The same advantages can also be achieved in cases when in the central area the shallow grooves are more sparsely located and/or they are narrower, wherein more of the smooth mantle surface is left between them than at the edge areas. Due to the linear loading between the reeling cylinder and the reel, the grooving at the edges can be used to direct the air to the exactly right area. Because there is more of the smooth loading surface, the linear load can be smaller than with cylinders grooved with the same spacing over the whole width.

Consequently, the cylinders of the invention are always provided at the edges of the mantle with zones of a given width, in which the total cross-sectional area of cross-sections of single wide grooves extending parallelly in the direction of the periphery of the mantle (the total cross-sectional area of the grooving) is greater than in the central area left between the zones.

The groove cross-sectional area refers to the area which, in a section taken along a plane extending in the radial direction of the cylinder, is limited by the bottom of the respective groove and the straight line extending across the grooves and coinciding with the smooth mantle surface.

By means of a wide profile of the grooving, the air left between the web and the reel can be removed. In such a case it is advantageous to design the profile of the groove in such a way that the risk of sharp edges marking the paper web is as small as possible. An advantageous shape is that the groove has a profile of a segment of a circle or close to it, and its arch radius is such that the width of the groove becomes 20 to 40 mm and the depth of the profile form becomes only about 1 mm or a few millimetres. Thus, the risk of marking the paper web at the edge point of the groove is very small.

In a construction according to the invention, no underpressure will be needed inside the reeling cylinder, and consequently no equipment to guide air through the shaft or expensive suction pump equipment will not be needed. Moreover, there is no need to drill holes in the cylinder, which is a very time-consuming manufacturing stage.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 shows a Pope reel-up in a schematic view seen from the side, but in such a way that only the components essential to the invention are illustrated,

Fig. 2 shows the reeling cylinder in a front view,

Fig. 3 shows a reeling cylinder according to a second embodiment in a front view,

Fig. 4 illustrates a narrow groove, and

Figs. 5 to 9 illustrate sections of the mantle of the reeling cylinder in such a way that the grooves machined on the surface are clearly visible.

Figure 1 does not show the parts of the support frame nor the equipment needed to move and load the reel spools, such as a device for initial reeling, which brings the empty reel spools onto the reeling cylinder to conduct a change and moves them into a reeling position, as well as reeling rails, on which the spool is moved during the reeling, and a loading mechanism, by which the roll is loaded by means of power units transmitting a loading force to the ends of the reel spool. The actual reeling cylinder 1 is journalled on the frame and is driven by the drive system of the paper machine. Figure 1 shows an empty reel spool 2 which is ready to be laid onto the reeling cylinder 1. A paper web W running from a paper machine or from a paper after-treatment machine, such as a coating machine, runs over the reeling cylinder 1 on a part of the circumference of its mantle and is wound onto the reel spool 2 to an increasing paper layer to form the machine reel R. The reel spool 2 located in the reeling position is also equipped with a drive.

Before a reel change, the complete reel spool 2 is removed from the surface of the reeling cylinder 1. A new reel spool 2 is laid onto the surface of the reeling cylinder 1. The speed of the complete machine reel is reduced, and a bag starts to form between the reeling cylinder 1 and the reel R from the paper web, which is blown around the spool 2. The paper web running onto the reel R is immediately torn, and the reel R can be transferred to further processing. Also other ways of exchange can be used.

A grooving 3 is machined on the surface of the reeling cylinder 1. Because paper machines have presently a very high speed, normally

more than 20 m/s, air tends to be pressed between the cylinder and the paper web in the gap 4 which is located at the point of junction of the web W running from the paper machine and the reeling cylinder 1, as well as in the reeling nip N which is left between the web W and the reel R. Air penetrated in the gap 4 tends to reduce the friction between the paper web and the reeling cylinder 1 and to cause the above-described air bag problem before the reeling nip N, causing wrinkling on the side of the reeling cylinder. The same risk of air bag formation is also caused by air left from the reeling nip N between paper layers, which also causes looseness in the roll. The grooving 3 comprises parallel flat or shallow grooves, which shall be described in more detail below, and which are used to allow air to discharge from underneath the uppermost web layers in the reel R. In the figure, the grooving 3 is illustrated with broken lines, and the depth of the grooving is exaggerated for the sake of clarity. Also the above-described air bags are shown by broken lines.

Figure 2 illustrates the reeling cylinder 1 of the invention in a front view. Zones located symmetrically with respect to the central line at the edge areas 6 of the mantle and having preferably equal widths are provided with a grooving 3, which at one end of the mantle is right-handed and at the other end of the mantle is left-handed. The shape of the grooving 3 in the edge areas 6 will be described hereinbelow.

In the central area 5 of the mantle, the cylinder is smooth, *i.e.* there is no grooving 3, or, as shown in Fig. 3, there is a grooving 3 whose total cross-sectional area is smaller than in the edge areas 6.

Figure 4 illustrates as an example a narrow groove 8 whose width is about 1 mm or 3 mm at a maximum. Such a groove, whose depth is, according to one embodiment, greater than its width, removes air squeezed in gap 4 between the reeling cylinder 1 and the incoming paper web W. The side walls of the grooves are parallel, but the cross-sectional form of the groove can also be such that the side walls diverge towards the bottom.

Figures 5 to 9 show the shapes of the grooving 3 in more detail. If the groove is widened, this has the effect of removing air packed from the reeling nip N in between the reel R and the paper web W reeled onto the reel R. Figure 5 shows parallel, wide and flat or shallow grooves 7 used as the grooving 3 at the ends of the cylinder. The width of the grooves 7 is several times, *e.g.* at least three times their depth, their profile has approximately the shape of a segment of a circle, and their width is about 20 to 40 mm and depth about 1 to 4 mm. The edges or side walls of the groove 7 form an obtuse angle with the smooth mantle surface of the cylinder.

The proportion of the parallel shallow grooves 7 in the cross-sectional area of the mantle is greater at the edge areas 6 than in the central area 5. In Fig. 5, this is achieved in such a way that there are no shallow grooves 7 in the central area 5, which is completely smooth. The grooves 7 of the edge area 6 are identical with respect to each other.

Figures 6 and 7 show a case in which there are grooves 7 also in the central area 5. The cross-sectional area of single grooves 7 is greater in the edge areas 6 than in the central area 5. In Fig. 6, this has been achieved in such a way that the depth of the grooves 7 is greater in the edge areas 6 than in the central area 5. Figure 6 also illustrates the determination of the cross-sectional area A of one groove 7 by hatching. In Fig. 7, in turn, the difference in the total cross-sectional areas A is realized in such a way that the width of the grooves 7 is greater in the edge areas 6 than in the central area. In Fig. 6, the grooves have equal widths and in Fig. 7 the grooves have equal depths in the edge areas 6 and in the central area 5, but they can be both wider and deeper in the edge areas 6. In the edge areas 6, the cross-sectional area of the grooves can also be arranged to increase gradually from the centre to the edges. In Fig. 6, this possibility is illustrated in such a way that the grooves 7 become deeper towards the edges.

Figure 8 shows an alternative, in which the grooves 7 are more closely spaced in the edge areas 6 than in the central area 5. These grooves 7 can be identical with respect to each other. The pitch can be constant in

the edge area 6, or, as shown in Fig. 8, it may become denser towards the edges.

Figure 9 shows a case combining shallow, flat wide grooves 7 and narrow grooves 8. Such a construction has an effect on both the removal of air packed between the web W and the reeling cylinder 1 and the removal of air packed before the nip underneath the paper web W reeled on the reel R. It is advantageous to make the grooving in a spiral form, *i.e.* in a helical configuration, around the mantle of the reeling cylinder. To make a grooving with both narrow grooves 8 and wide grooves 7, several narrow helical grooves 8 can be arranged for example parallel to and within each other at a given spacing, wherein the pitch of each groove 8 is the product of the number of parallel grooves 8 and spacing. Wide, shallow grooves 7 next to each other are made on top of the narrow grooves for example in such a way that the width of one wide groove extending in a spiral-like fashion around the cylinder is part of the pitch of said narrow grooves, and the helix pitch is the same as the pitch of the narrow grooves 8, wherein a smooth part with a certain width is left in between, containing only narrow grooves 8.

At the present running speeds (more than 20 m/s), and with coated paper grades at even lower speeds, it is advantageous to use narrow grooves 8 over the whole width of the mantle. Thus, in all the cases of Figs. 5 to 8, the narrow grooves 8 can be overlapping with the wide grooves 7 as shown in Fig. 9.

Figure 9 shows the idea applied in the embodiment of Fig. 5; that is, the shallow grooves 7 are only at the ends, and in the central area 5 there are only the narrow grooves 8 and the central area is otherwise fully smooth. In the case that there are both wide grooves 7 and narrow grooves 8 in the edge areas 6, and narrow grooves 8 in the central area 5 which is otherwise smooth, the proportion of the grooving of the area of the mantle surface is clearly greater in the edge areas 6 than in the central area 5, *e.g.* at least two times greater.

When the reel spool 2 is being laid down in its reeling position, it is first supported on its whole weight by the reeling cylinder 1, but when the

spool is moved downwards in the final reeling position, implemented with reeling rails or another support structure for supporting the ends of the reel, wherein the central axis of the reeling cylinder 1 and the central axis of the reel spool 2 are almost in the same horizontal plane or there is only a small angle of *e.g.* 15° between them, its weight is no longer directed to a great extent to the surface of the reeling cylinder 1, and therefore the linear pressure against the reeling cylinder is small due to the loading at the ends of the spool 2, particularly in the central part of the spool because of bending of the long spools. Another way of increasing the linear pressure in the centre would be to camber (crown) the reeling cylinder 1. The partial shallow grooving of the reeling cylinder 1 according to the invention, wherein the central area 5 of the cylinder is primarily smooth or there are only few shallow wide grooves 7, has an effect similar to that of cambering. Consequently, the construction of the invention can be used to level out the linear pressure over the full width of the reel spool.

A cylinder surface which is only partially grooved with shallow grooves is less expensive and faster to manufacture than a smooth roll which is grooved with shallow grooves over the full width of the mantle or cambered (crowned) to be thicker in the central area of the mantle. It is also obvious that the need for linear loading is reduced, because there is more solid line to be loaded in the central area of the cylinder. Moreover, the maximum running speed can be raised, because the behaviour of air can be controlled.

In the construction according to the invention, the reeling nip N is fully closed in the centre, preventing a quantity greater than the natural roughness volume of the paper from entering the reel R.

One useful way of grooving the reeling cylinder is to machine the grooves in the edge areas 6 of the cylinder mantle over at least 1/6 of the length of the cylinder mantle starting from both ends. As an example, it can be said that in a paper machine with a reeling cylinder having a width of 9 metres, a length of 1.5 metres of the mantle is grooved from both ends. Thus, a non-grooved area of 6 metres is left in the central area of the mantle. The non-grooved area can be even

narrower, and it is preferably at least 40 % of the length of the mantle in the axial direction.

A corresponding proportioning can be used when the central area 5 is provided with wide shallow grooves 7 whose total cross-sectional area is smaller than in the edge areas 6.

In the mantle of the reeling cylinder 1, the direction of the helix of one edge area is preferably opposite to that of the direction of the helix in the other end, wherein they function in a way similar to a screw conveyor from the centre towards the edges, but the helices can also be arranged in the same direction.

The invention is not limited to the shape of the grooves or to the fact, whether separate grooves are machined to extend around the mantle in the peripheral direction or whether one or more of continuous grooves are machined to form a helix with a low pitch. According to the invention, it is also feasible to use the above-mentioned surface structure in all cylinders that are intended in the reel-up to be in nip contact with the reel to be formed of the paper web, such as auxiliary rolls, rolls of carrier-roll reel-ups and rolls of pressure roller reel-ups.

The surface structure of the cylinder according to the invention can be achieved by machining the grooves according to above-mentioned principles on the surface of a full-width cylinder mantle or by assembling the cylinder in successive parts in the axial direction, wherein the different parts already have a suitable structure in the mantle surface. These parts may each have a grooving of a given type, continuing similarly over the full width of the part, wherein by combining different parts it is possible to make a full-width cylinder with a structure according to the invention.

Claims:

1. Reel-up for a paper web, comprising a reeling cylinder (1) equipped with a grooving (3) on the mantle surface, wherein the grooving comprises parallel shallow grooves (7); a reel spool (2), around which the web (W) is reeled into a reel (R); as well as means for loading the reel spool (2) and the reeling cylinder (1) against each other to achieve a reeling nip (N) between the reeling cylinder (1) and the reel (R); **characterized** in that the total cross-sectional area of the grooving formed by the parallel shallow grooves (7) is greater in the edge areas (6) of the mantle of the reeling cylinder (1) than in the central area (5) of the mantle of the reeling cylinder (1).

2. Reel-up according to claim 1, **characterized** in that the proportion of the shallow grooves (7) of the surface area of the mantle is greater in the edge areas (6) than in the central area (5).

3. Reel-up according to claim 1 or 2, **characterized** in that the cross-sectional areas of single shallow grooves (7) are greater in the edge areas (6) than in the central area (5).

4. Reel-up according to claim 3, **characterized** in that the depths and/or widths of the shallow grooves (7) are greater in the edge areas (6) than in the central area (5).

5. Reel-up according to any of the preceding claims, **characterized** in that the shallow grooves (7) are spaced more densely in the edge areas (6) than in the central area (5).

6. Reel-up according to any of the claims 1 to 5, **characterized** in that the central area (5) of the reeling cylinder (1), in which the total cross-sectional area of the grooving formed by the shallow grooves (7) is smaller than in the edge areas (6), constitutes at least 40 % of the width of the mantle.

7. Reel-up according to any of the preceding claims 1 to 6, **characterized** in that on at least part of the mantle of the reeling cylinder (1), the width of the shallow grooves is 20 to 40 mm.

8. Reel-up according to claim 1, **characterized** in that shallow grooves (7) exist only in the edge areas (6) of the mantle, and the central area (5) of the mantle is left ungrooved with shallow grooves.

9. Reel-up according to claim 8, **characterized** in that the central area (5) of the reeling cylinder (1), left ungrooved with shallow grooves, constitutes at least 40 % of the width of the mantle.

10. Reel-up according to any of the preceding claims 1 to 9, **characterized** in that the shallow grooves (7) are formed on the mantle surface of the reeling cylinder (1) as parallel grooves extending around the periphery of the mantle.

11. Reel-up according to any of the preceding claims 1 to 9, **characterized** in that the shallow grooves (7) are formed on the mantle surface of the reeling cylinder (1) as one or several helical grooves.

12. Reel-up according to any of the preceding claims, **characterized** in that the surface of the reeling cylinder is also equipped with several narrow grooves (8).

13. Cylinder in a reel-up for a paper web, which is intended for a nip contact with a reel to be formed of the paper web, wherein the mantle surface of the cylinder is equipped with a grooving (3) which comprises parallel shallow grooves (7), **characterized** in that the total cross-sectional area of the grooving formed by the parallel shallow grooves (7) is greater in the edge areas (6) of the mantle of the cylinder (1) than in the central area (5) of the mantle of the cylinder (1).

14. Cylinder according to claim 13, **characterized** in that the proportion of the shallow grooves (7) of the surface area of the mantle is greater in the edge areas (6) than in the central area (5).

15. Cylinder according to claim 13 or 14, **characterized** in that the cross-sectional areas of single shallow grooves (7) are greater in the edge areas (6) than in the central area (5).

16. Cylinder according to claim 15, **characterized** in that the depths and/or widths of the shallow grooves (7) are greater in the edge areas (6) than in the central area (5).

17. Cylinder according to any of the preceding claims 13 to 16, **characterized** in that the shallow grooves (7) are more densely spaced in the edge areas (6) than in the central area (5).

18. Cylinder according to any of the claims 13 to 17, **characterized** in that the central area (5) of the cylinder (1), in which the total cross-sectional area of the grooving formed of shallow grooves (7) is smaller than in the edge areas (6), constitutes at least 40 % of the width of the mantle.

19. Cylinder according to any of the preceding claims 13 to 18, **characterized** in that on at least part of the mantle of the cylinder (1), the width of the shallow grooves (7) is 20 to 40 mm.

20. Cylinder according to claim 13, **characterized** in that shallow grooves (7) exist only in the edge areas (6) of the mantle, and the central area (5) of the mantle is left ungrooved with shallow grooves.

21. Cylinder according to claim 20, **characterized** in that the central area (5) of the mantle of the cylinder (1), ungrooved with shallow grooves, constitutes at least 40 % of the width of the mantle.

22. Cylinder according to any of the preceding claims 13 to 21, **characterized** in that the shallow grooves (7) are formed on the surface of the mantle of the cylinder (1) as parallel grooves extending around the periphery of the mantle.

23. Cylinder according to any of the preceding claims 13 to 21, **characterized** in that the shallow grooves (7) are arranged as one or several helical grooves on the surface of the mantle of the cylinder (1).

24. Cylinder according to any of the preceding claims 13 to 23, **characterized** in that the cylinder surface also comprises several narrow grooves (8).

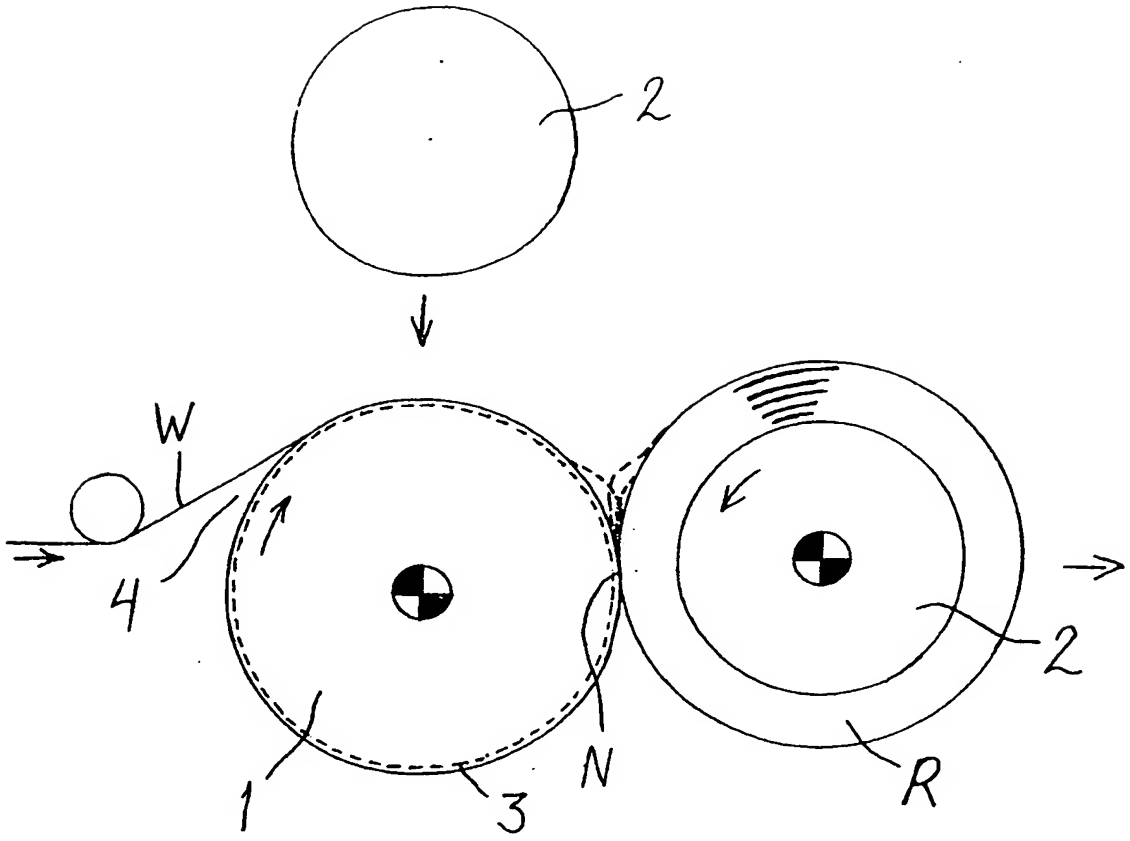

Fig. 1

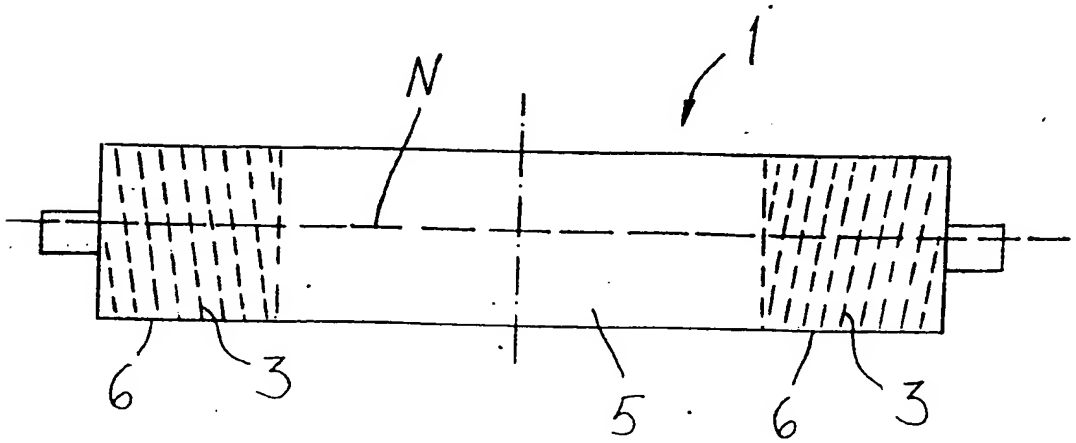

Fig. 2

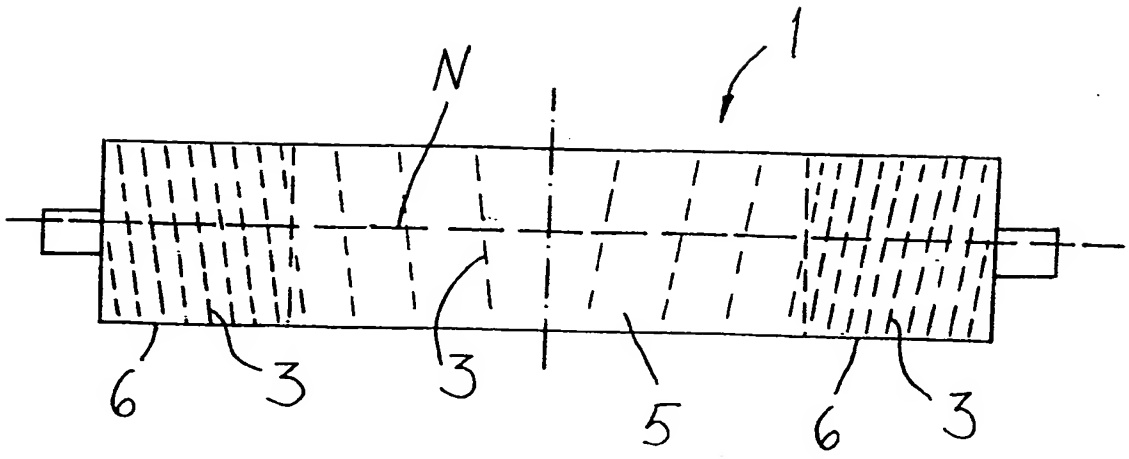

Fig. 3

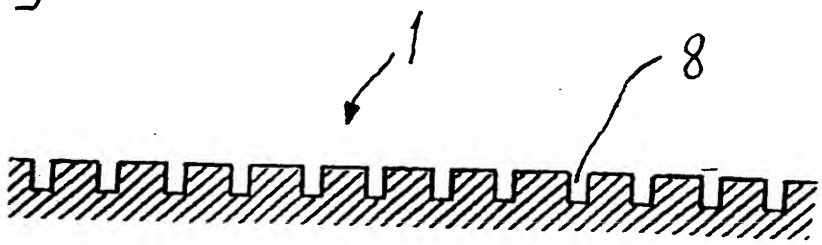

Fig. 4

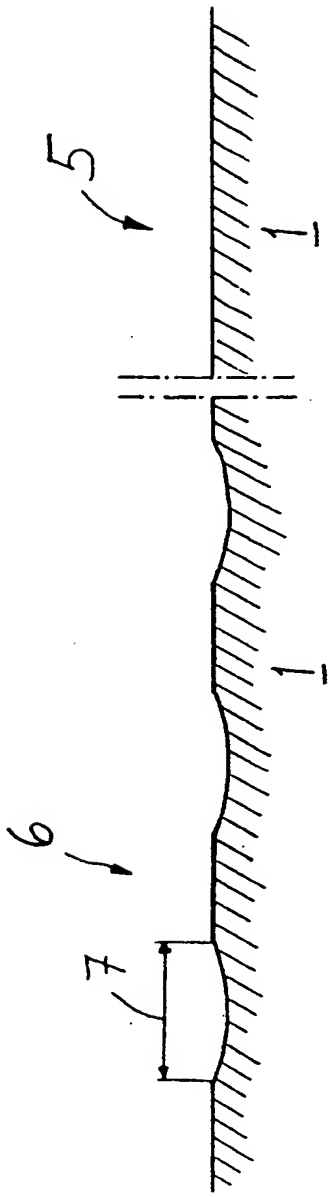

Fig. 5

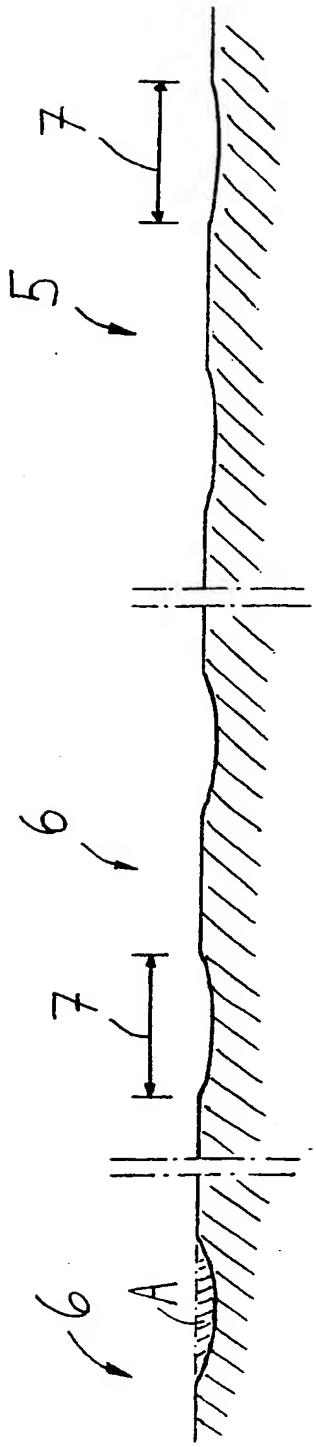

Fig. 6

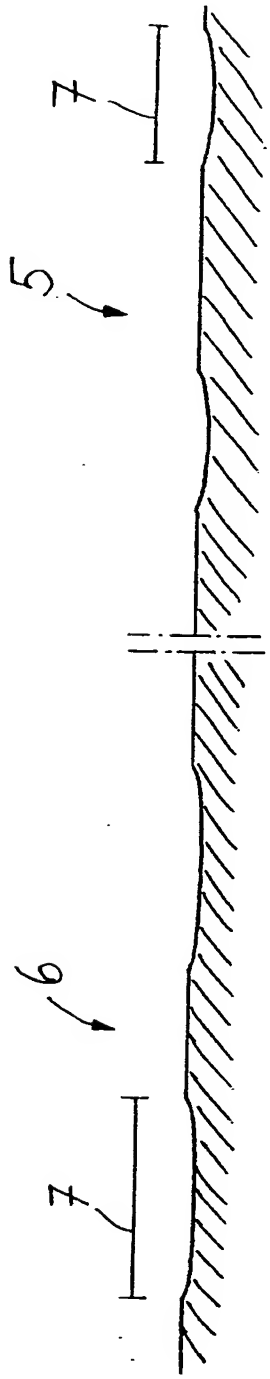

Fig. 7

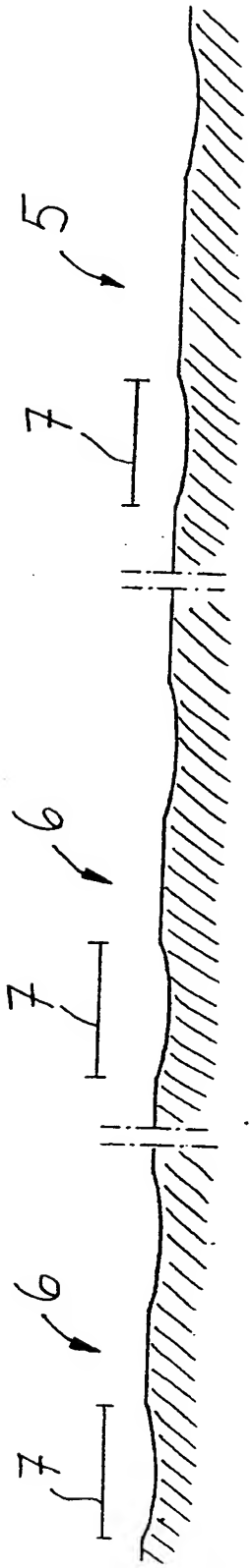

Fig. 8

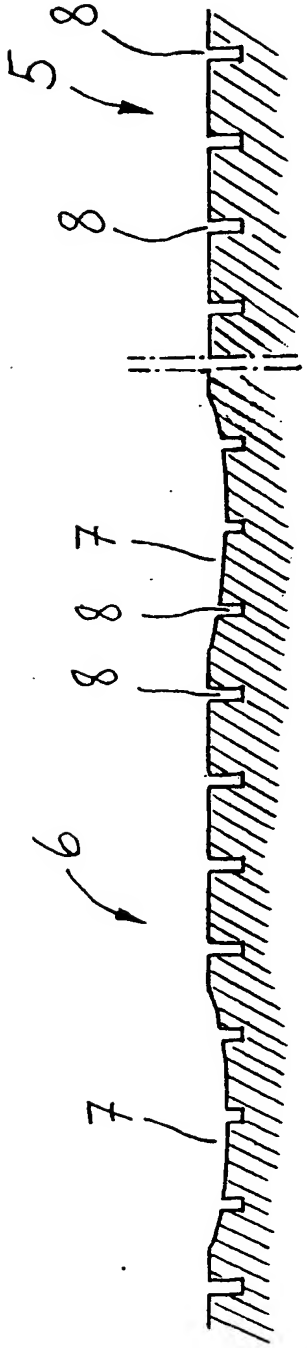

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00429

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B65H 27/00, B65H 23/025 // F16C 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B65H, F16C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y		2-4,8-10,12, 14-16,20-22, 24
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Y	US 3462053 A (R.D. BEHR), 19 August 1969 (19.08.69), figure 3, claims 1,5,7	2,8,9,10,14, 20,21,22
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Y	US 4566162 A (G. BRANDS), 28 January 1986 (28.01.86), figures 3,5	4,16
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 Sept 1999	27 -09- 1999
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00429

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0114166 A1 (ELLNER, F.), 1 August 1984 (01.08.84)	
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A	EP 0709328 A2 (MINNESOTA MINING AND MANUFACTURING COMPANY), 1 May 1996 (01.05.96)	
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INTERNATIONAL SEARCH REPORT

Information on patent family members

30/08/99

International application No.
PCT/FI 99/00429

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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